2002

The risk of injury to Pakistani children

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A Thesis Submitted to the

Yale University School of Medicine

in Partial Fulfillment of the Requirements for the

Degree of Doctor of Medicine

by

Michael Scott Singer

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THE RISK OF INJURY TO PAKISTANI CHILDREN. Michael S. Singer[1] and Abdul Ghaffar.[2] [1]Yale University School of Medicine, New Haven, CT, USA, and [2]Ministry of Health, Islamabad, Pakistan. (Sponsored by David Katz, Dept. of Epidemiology and Public Health, Yale University School of Medicine).

Injury is responsible for 1 million child fatalities every year, 98% of which occur in developing countries. There is a critical need to determine *how* these children are injured, *who* is most at risk, and *when*. Pakistan, home to 60 million children, is ideal for this work. Our Specific Aims were (1) to determine the primary causes of injury to Pakistani children; (2) identify demographic factors that predispose childen to injury; (3) test when, in the context of their schedules, children were more likely to be injured, and whether these patterns differed for preschool versus school children; (4) interview families for the circumstances and consequences of injuries; and (5) distill our findings into culturally and economically feasible recommendations. We interviewed 300 inpatients at the Children's Hospital in Islamabad: 150 injury patients and 150 controls. For each Specific Aim, responses were analyzed by appropriate descriptive, case-control, or cohort methods. The most common causes of injury were falls (59%), road collisions (16%), and burns (13%). Most children (79%) were unsupervised. Except for burns, boys outnumbered girls 2:1. The case-control study found differences in (1) the mother's level of education, (2) size of the home, and (3) number of children in the home (all $p < .05$). The most perilous time of day was 3-6 PM. Compared to preschoolers, school children showed elevated risk on weekends (OR 4.0, $p < .001$) and reduced risk during school (OR 0.2, $p < .0001$). The risk for preschoolers remained stable over the week. In summary, poor supervision, poor education, and crowded homes contributed to injury in our sample of Pakistani children. We discuss steps to (1) keep children off roofs and isolate them from fires and traffic, (2) promote supervision, (3) educate parents, and (4) provide safe play options.

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In cooperation with

The Ministry of Health, Government of Pakistan

Supported by

The Wilbur Downs International Health Fellowship

ACKNOWLEDGMENTS

Dr. Abdul Ghaffar (Ministry of Health, Government of Pakistan), my advisor, played an important role in designing and carrying out this study. He, his wife Lubna, and his children Kandy and Kayhan provided warm hospitality during my time in Islamabad.

Dr. David Katz graciously served as my Yale sponsor for this thesis. Dr. Junaid Razzak served as my local reader. Dr. Curtis Patton, Dr. Michele Barry, Dr. Linda Degutis, Priya Nalkur, Brett Cohen, Dr. Maya Salameh, and Dr. Deborah Wexler provided valuable comments. Dr. Adnan Hyder and Dr. Auguste Fortin VI helped me plan this study. Gautami Shah and Faiza Issa instructed me in Urdu.

Dr. Aliya Khan helped me identify patients and collect information. I am grateful to Tarik Javeid Malik, Yousaf Khan Khattak, Syed Manzar Abbas Naqvi, Dr. Zahir Abbasi, Dr. Rizwan Afzal, Dr. Zubair Hassan, and Dr. Nauman Zafar for logistic support in Pakistan.

A number of government offices supported me in my work. They include the Health Services Academy, Ministry of Health, Government of Pakistan; Pakistan Institute of Medical Sciences; Islamabad Capital Territory Police; District Headquarters Hospital, Rawalpindi; and the Consulate General of Pakistan, New York. This thesis was generously supported by the Wilbur Downs International Health Fellowship and the Yale Committee on International Health. I thank the Yale University MD/PhD Program for other support.

As always, I thank Dr. Gordon Shepherd, my family, and my friends for their inspiration.

New Haven, Connecticut

January 2002

In memory of Rizwana

فَإِنَّ مَعَ العُسرِ يُسرًا

إِنَّ مَعَ العُسرِ يُسرًا

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INTRODUCTION

Over 1 million children die from injuries every year, the equivalent of nine jumbo jets full of children crashing every day (Krug et al, 2000; Innocenti Research Centre, 2001). This mortality is compounded by an enormous morbidity: one Dutch study found that for every child death due to injury, there were 160 hospital admissions and 2,000 emergency department visits (Consumer Safety Institute, 1997). Injuries occur precipitously, robbing decades of life from healthy children and ruining families, both emotionally and financially. They have no place in the human life cycle. Consistent with this concept, evidence shows that most injuries could be prevented (Baker et al, 1992; Barss et al, 1998; Grossman, 2000; Innocenti Research Centre, 2001).

While injury is the chief cause of child mortality in the industrialized world, it is predominately an epidemic of poor countries. Of the 1 million fatalities per year, 98% occur in the developing world (Innocenti Research Centre, 2001). Many of these countries have entered a phase of epidemiologic transition in which vaccination and sanitation have reduced many childhood infections, but motorization and urbanization have led to concomitant rises in injury rates (Omran, 1977; Smith and Barss, 1991; Kozik, 1999). Fertility rates remain high in many of these countries, implying that the number of children at risk will continue to rise. The tragic result is that the burden of child injury will multiply well into the future and will be shouldered by the world's poorest countries.

The financial and social costs of injury can be profound. A Massachusetts study found the average cost of treating an injured child to be USD 4000 (Malik et al, 1991). The direct cost of a fatal motor vehicle collision was estimated to be USD 5000 in one Indian study, or 17x per capita GNP (Central Road Research Institute, 1982); USD 352,000 in one American study, or 20x per capita GNP (Rice et al, 1989); and USD 500,000 in one Kuwaiti study, or 36x per capita GNP (Jadaan, 1990). In the United States the costs of unintentional child injuries for one year were USD 14 billion in lifetime medical spending, USD 1 billion in other resources, and USD 66 billion in work losses (Miller et al, 2000). Injuries cause pain, keep children from school or play, and delay social and motor development. Especially in developing countries, family members miss work to care for the child, and sometimes the whole family must leave home for a distant, more modern hospital. Injuries claim children who would otherwise be poised to contribute to family, society, and the economy. Parents in developing countries often depend on children to support them when they become elderly, and an injury may forfeit this important form of social security (Barss et al, 1998).

Injury prevention and control, which focus on modifications of behavior, equipment, and the environment, have been widely successful in industrialized countries (see Grossman, 2000; Innocenti Research Centre, 2001; see Discussion). Of course, these efforts require research and considerable funds, and it is not clear that interventions successful in industrialized countries will yield similar results in other contexts (see Graitcer, 1992).

Developing countries have less money to invest and vastly more children to protect (as a proportion of total population). One way to simplify the problem is to identify children most at risk and those for whom prevention is likely to yield the most benefit (see Faelker et al, 2000). This entails several questions: *how* do injuries occur, *who* is most at risk, *and where* and *when* do they occur? Most developing countries have yet to examine these questions. The results would be of obvious value for injury prevention (Forjuoh and Gyebi-Ofosu, 1993).

We have chosen Pakistan to test this approach. A national injury survey has already provided an outline of the problem (Ghaffar et al, 1999). Much of this South Asian country of some 145 million people is still in the early phases of modernization and demographic transition. Children make up 43 percent of the population, substantially more than the 22 percent they make up in the United States (US Census Bureau, 2000). Health care and economic indicators are not optimistic. Infant mortality is 90 per 1000 live births, and life expectancy is 60 years (US Census Bureau, 2000). Per capita GNP is USD 2000 in purchasing power parity, and 34% of the population is below the poverty line (CIA World Fact Book, 2001). The literacy rates of 55% for men and 29% for women reflect limited access to education and some of the world's most pronounced gender bias (CIA World Fact Book, 2001).

As in most developing countries, proliferations in motor vehicles have contributed to rising injury rates (Ghaffar et al, 1999; Hyder et al, 2000), while falls, household burns,

snakebites, and drownings continue (Barss et al, 1998). Poor law enforcement, perilous road conditions, and competition of motor vehicles, cycles, animals, and pedestrians for the same crowded space contribute to transport-related injuries (see Razzak and Luby, 1998; Hyder et al 2000). Poverty and overcrowding encourage children to play on rooftops and roads. Many children work and face occupational hazards (Aftab, 1991). There are insufficient regulations and education for safer roads, vehicles, households, toys, and play areas. Deficiencies in emergency response systems, medical care, and rehabilitation further contribute to losses and suffering (Barss et al, 1997; Hyder et al, 2000; Razzak et al, 2001).

We studied injured children at one of Pakistan's leading pediatric hospitals, which allowed us to focus on serious injuries from a wide catchment area (see Discussion). First, we describe *how* injuries occurred. Second, we describe *who* was injured, with a case-control study of socioeconomic risk factors. Third, we present a prospective analysis of *when* injuries occurred in the context of the children's daily routines, with comparison of preschoolers and students. Fourth, we provide case studies of patients and their families. Finally, we propose strategies to minimize the most common types of injury and focus injury prevention efforts on populations, places, and periods of maximum risk.

SPECIFIC AIMS AND STATEMENT OF HYPOTHESES

Specific Aim 1. To determine the primary causes of injury to Pakistani children. *Method*: Descriptive.

Specific Aim 2. To identify which children, based on demographic factors, are more likely to be injured. *Method*: Case-control. *Null Hypothesis*: There will be no difference between cases and controls for the variables of sex, age, income, vaccination status, maternal education, children in home, rooms in home, or type of shelter.

Specific Aim 3. To test when, in the context of their schedules, children are more likely to be injured, and whether these patterns differed for preschoolers versus school children. *Method*: Prospective comparison. *Null Hypotheses*: A. The frequency of injuries will be uniform throughout the day. B. For different periods of the week, there will be no difference in injury rates between preschoolers and students. C. For different periods of the week, there will be no difference in injury rates between preschoolers and a simple model of uniform injury rates. D. For different periods of the week, there will be no difference in injury rates between students and a simple model of uniform injury rates. E. There will be no difference in injury rates between Ramadan and the month before.

Specific Aim 4. To interview families for the detailed circumstances and consequences of an injury. *Method*: Case studies.

Specific Aim 5. To distill our findings into culturally and economically feasible recommendations.

METHODS

Location and time

The study was carried out at Children's Hospital (CH) of the Pakistan Institute of Medical Sciences, Islamabad. CH is a 200-bed pediatric facility with a full surgery department and intensive care unit. It serves a broad catchment area in northern Pakistan. Patients come from Islamabad, nearby Rawalpindi, other parts of Punjab, Kashmir, Northern Areas, Northwest Frontier Province (NWFP), and Afghanistan (several other hospitals overlap with this catchment area). Children who die in the field are also brought to CH for post-mortems. We conducted interviews for 60 days between October and December 2000. The study was timed to include the fasting month of Ramadan and one full month before.

Figure 1: Map of Pakistan illustrating Islamabad and catchment area (rose).

Subjects

Cases were children up to 12 years old (the hospital limit) admitted to CH for any complaint as the direct result of an injury. Children on return admissions for the same injury were excluded. Injury was defined prospectively as any fracture, burn, foreign body, internal injury, blunt injury, crush, laceration, penetration, animal attack, snake bite, poisoning, or drowning. All comers during the 60-day period were invited to participate if a parent or guardian was present. Controls were children up to 12 years old admitted CH for any complaint that did not result from injury.

Consent and protection procedures

The study was carried out with prior review and approval from the Yale University School of Medicine Human Investigations Committee (HIC). Prior review and approval were also obtained from CH and the Health Services Academy, Ministry of Health, Government of Pakistan. Family interviews were conducted with one or both parents, or the legal guardian. All interviews were conducted by the author (MSS) in Urdu. Nurses fluent in Punjabi, Pashto, or Dari interpreted when needed. An interview outline and script were used to ensure consistent interview technique. The HIC protocol was strictly followed to ensure informed consent and patient confidentiality. Names were not recorded.

Data collection and analysis

Sex, age, vaccination status, and years of maternal education were recorded by family report. The address was the patient's place of residence when the injury occurred. The number of children in household was those in the immediate family at the patient's place of residence, including the patient. The number of rooms in household was those occupied by the parent(s) or their dependents. A tent or hut counted as one room. Household income was the family's estimate for parent(s) and dependents in a typical month. Families who subsisted on crops or charity were estimated to earn 1500 Rupees (USD 30) per month. Time and date of injury and other descriptors were also recorded.

Results were analyzed by the chi-square test, chi-square test for goodness of fit, Fisher's exact test, or binary logistic regression. Values were sorted into meaningful categories as follows. Ages 2 and 5 were chosen as boundaries because they represent mobility and school age, respectively. Income of 5000 Rupees per family per month represents the upper boundary for the working class. For maternal education, 1 and 8 years were estimated as milestones for basic literacy and secondary education, respectively. For number of rooms in house, 3 was estimated as the size of a typical home. For number of children, 2 and 4 were estimated as boundaries for (1) easy and (2) difficult supervision by one adult. The logistic regression model used dichotomized variables as follows: age > 5 years, income over 5000 Rupees, maternal education (yes or no), children in home > 4, rooms in home > 3. We used SAS software (SAS Institute, Cary, NC) for all analyses.

RESULTS

Description of sample

Sample sizes. During the study period, 190 patients qualified as cases, 150 of which were contacted and interviewed. For the other 40 patients, one patient's family did not wish to participate, and the other 39 patients were not enrolled because a parent could not be contacted. An equal number of controls were randomly selected and enrolled: 100 from medical and 50 from surgical wards.

Catchment area. For cases, 36% were from Islamabad, 36% from Rawalpindi, 15% from other parts of Punjab Province, 6% from Kashmir, and 6% from the Northern Areas and NWFP (5% were Afghani refugees). For controls, 28% were from Islamabad, 27% from Rawalpindi, 29% from other parts of Punjab Province, 6% from Kashmir, 10% from the Northern Areas and NWFP, and 1% from Afghanistan (3% were Afghani refugees).

Causes of injury

Table 1 lists the reported causes of injury. Falls accounted for most admissions, followed by road collisions and burns. Overall, only 21% of children were accompanied by an adult when the injury occurred. Families knew the place of injury in 135 of 150 cases (90%). Of these cases, 43% occurred on roofs, 29% outside, 23% inside the home, and 5% near the home.

Falls. The 88 children with a history of fall presented with head injury, serious fractures, or both (see Figure 2). Only 15% of these children were accompanied by an adult when they fell (lower than the overall mean). Most (70%) fell from a rooftop, typically at home from an unprotected roof (only 12% of roofs were protected by rails, walls, or fences). Kite flying and cricket were common activities. The M:F ratio for fall cases was 71:29, similar to the overall ratio for cases and controls. Half of the children were under 5 years old. The mean family income was 5200 Rupees, similar to the overall mean.

Type	Number	Percent
CASES	150	100
Fall	88	59
Road collision	24	16
Burn	20	13
Other	18	12
Foreign body in esophagus	5	3
Animal attack	3	2
Foreign body in bronchus	2	<2
Toxin	2	<2
Blunt trauma	2	<2
Intentional	2	<2
Sharp trauma	1	<2
Gunshot	1	<2

Table 1. Causes of injury

Figure 2: Radiograph of skull fractures in a child who fell from the roof.

Road collisions. Most of the 24 children with a history of road collision were admitted due to head injury or serious fractures. Only 36% of these children were accompanied by an adult at the time of injury (above the mean). Most of the children were pedestrians (68%). The remaining children were playing on the road (18%) or in vehicles (14%). Most injuries occurred during daylight hours (80%). The M:F ratio of 71:29 was similar to the overall mean. The mean family income was relatively low at 3300 Rupees.

Burns. Of the 20 children admitted with burns, 32% were accompanied by an adult when the burn occurred (above the overall mean). Many burns occurred near dinner time: 60% between 3 and 9 pm; 35% between 5 and 7 pm. Most children were at play. In 85% of cases the burn source was at ground level. Burn sources included stoves and cooking fires (60%), tea or hot water (30%), and outdoor fires (10%). In contrast to other types of injury, the M:F ratio was 50:50. Half of the children were 2 years or under. Income was below the overall mean at 4600 Rupees.

Other causes. Seven children had a foreign body (corn kernel, peanut, coin, or whistle) in the esophagus or bronchus; they were mostly under three years old. Three animal attacks occurred, two by horses and one by a wild boar. Two children ingested toxic substances (kerosene and thyroid hormone pills). Only two patients reported intentional injuries. One patient suffered a gunshot wound in a drive-by shooting reportedly aimed at his father. The other was pushed from a swing by another child.

Case-control study

Table 2 compares cases and controls for different descriptors. Both samples had the same sex ratios of 67% males and 33% females. Cases tended to be older than controls ($p < 0.001$). Children 5 and over made up most of the cases; in contrast, children 2 and under made up most of the controls. Reasons for these differences are discussed below.

Income. Cases reported significantly higher income than controls: 25% of cases reported > 5000 Rupees per month, compared to 12% of controls ($p = 0.045$). Mean incomes were 5570 Rupees for cases and 4530 Rupees for controls.

Vaccination status. Children two years and older were included in these calculations. Both groups reported vaccination rates of 85-86% (n.s.).

Mother's education. Case mothers reported significantly less education than control mothers: 17% of case mothers reported secondary education, compared to 33% of controls; 53% of case mothers never attended school, compared to 45% of controls ($p = 0.016$).

Children in household. Cases reported significantly more children in the home: 36% of case mothers reported > 4 children, compared to 28% of controls ($p = 0.047$).

Rooms in home. Cases reported significantly fewer rooms in the home: 21% of cases reported > 3 rooms, compared to 33% of controls ($p = 0.023$).

Type of shelter. Cases were more likely to live in tents than controls: 6% for cases and 1% for controls ($p = 0.023$ by Fisher's exact).

Factor	Cases (*N*=150)		Controls (*N*=150)		P value
	Number	Percent	Number	Percent	
SEX					
Male	100	67	101	67	
Female	50	33	49	33	0.902
AGE (years)					
Under 2	21	14	89	59	
2-5	63	42	32	21	
Over 5	66	44	29	19	<0.001
INCOME (Rp. per month)					
Up to 5000	92	61	117	78	
Over 5000	38	25	26	17	0.045
Not reported	20	13	7	5	
VACCINATIONS					
Current	120	80	82	55	
Not current	21	14	14	9	0.947
Not applicable	9	6	54	36	
MATERNAL EDUCAT.					
No school	79	53	67	45	
1-8 years	32	21	32	21	
>8 years	25	17	49	33	0.016
Not reported	14	9	2	1	
CHILDREN IN HOME					
1-2	37	25	58	39	
3-4	52	35	49	33	
>4	54	36	42	28	0.047
Not reported	7	5	1	1	
ROOMS IN HOME					
1-3	112	75	99	66	
>3	31	21	50	33	0.023
Not reported	7	5	1	1	
TYPE OF SHELTER					
Tent	9	6	2	1	
House	134	89	144	96	0.023*
Not reported	7	5	4	3	

Table 2. Descriptors for cases versus controls. All P values by chi-square except (*) by Fisher's exact test. Comparisons for respondents only.

Logistic regression (LR). Table 3 shows the outcome of our logistic regression model. The results compared favorably with the chi-square analyses: age, income, maternal education, rooms in home, and type of shelter proved to be important factors in the model. The number of children in the home, however, did not emerge as a significant variable in the logistic regression model.

Variable	P value (in model)	P value (if removed)
AGE	< 0.001	< 0.001
INCOME	< 0.001	< 0.001
MATERNAL EDUCAT.	0.050	0.047
ROOMS IN HOME	0.004	0.003
TYPE OF SHELTER	0.033	0.015

Table 3. Logistic regression for injury risk factors (forward conditional model). Model included cases and controls with complete records only (N = 265, 88%)

Temporal risk patterns

Ramadan. Studies in other Muslim countries have noted an increase in injury rates during the month of Ramadan (Bener et al, 1992; Shanks et al, 1994; see also Langford et al, 1994). With 71 cases during Ramadan and 75 cases the month before, our sample showed no evidence of increased risk during Ramadan.

Hour. A child's risk depended on the time of day. Figure 3 shows the frequency of injuries in 3-hour periods. For both preschoolers and students, the frequency was low between 9 PM and 6 AM. Frequency rose during the day, peaked between 3 PM and 6 PM, then declined after 6 PM for preschoolers and after 9 PM for students.

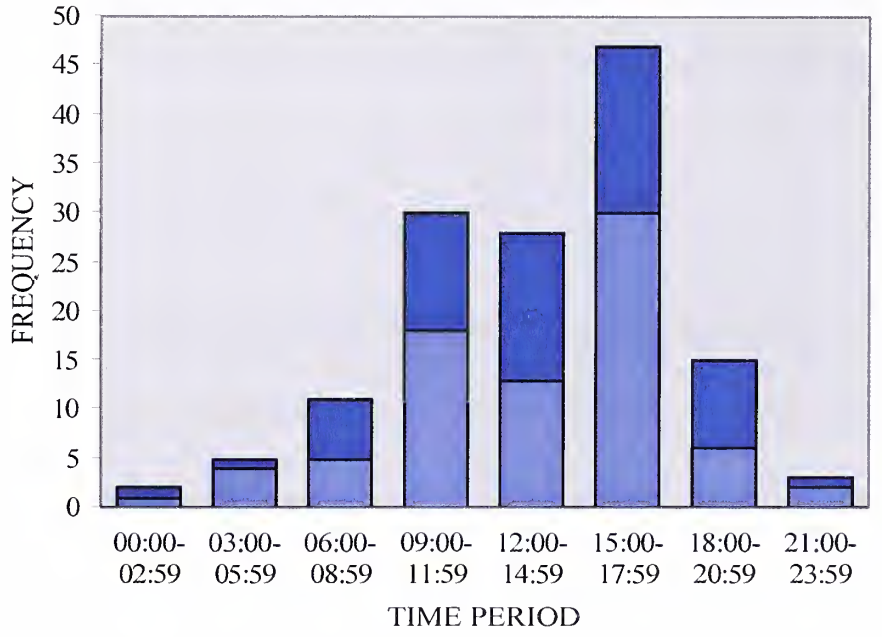

Figure 3: Frequency of injury for different times of day.

Preschoolers, below. Students, above.

The Children's Daily Routine. The risk of injury further depended on the day of week, and whether the child attended school. We surveyed children on their typical daily schedule and divided it as follows: "Sleep Time," Monday-Sunday 22:00-06:00; "Before School," Monday-Saturday 06:00-08:00; "School Time," Monday-Thursday and Saturday 08:00-14:00, Friday 08:00-12:00; "After School," Monday-Thursday 14:00-22:00; "Friday PM" (when children are dismissed for prayers), 12:00-22:00, and "Holiday Time," Saturday 14:00-22:00, Sunday 06:00-22:00, and national holidays 06:00-22:00.

Table 4 presents the number of injuries in each time period for students (ST) and preschoolers (PS). We also devised a model (M) to predict the distribution of injuries expected by chance. The model makes two assumptions: (1) no injuries occur during Sleep Time (see Figure 2); and (2) injuries occur with equal frequency during all other periods. The proportion of injuries expected for each period was calculated as the proportion of hours occupied by each period, with the exception of Sleep Time.

Table 5 shows the odds ratios (ORs) for comparisons of students, preschoolers, and the model. A critical period of risk for students was Holiday Time, with an OR of 4.0 ($p < 0.001$). A pronounced period of safety for students was School Time, with an OR of 0.1 ($p < 0.0001$). The same patterns emerged when students were compared to the model, with ORs of 2.5 for Holiday Time and 0.2 for School Time. Comparison of preschoolers with the model showed ORs of 1.0-1.2 in four of five time periods. This implies that the model

successfully predicted the distribution of preschooler injury; differences between students and preschoolers (see above) were more likely due to the *student* schedule and behavior.

Time period	Preschoolers (PS)		Students (ST)		Model (M)	
	Number	Percent	Number	Percent	Hours	Percent*
Total	76	100	64	100	112	NA
Sleep Time	1	1	1	2	0	NA
Before School	3	3	5	8	12	11
School Time	27	31	4	6	34	30
After School	22	26	17	27	32	29
Friday PM	7	8	4	6	10	9
Holiday Time	16	19	33	52	24	21
Unknown	10	12	0	0	NA	NA

Table 4. Injuries in the context of children's daily routine.

Time period	Odds Ratios (95% CI), P value		
	ST vs. PS	PS vs. UM	ST vs. UM
Before School	2.1 (0.4-11.4), $p = 0.538$	0.4	0.7
School	0.1 (0.03-0.4), $p < 0.0001$	1.2	0.2
After School	0.9 (0.5-1.6), $p = 0.901$	1.0	0.9
Friday PM	0.7 (0.2-2.7), $p = 0.739$	1.0	0.7
Holiday Time	4.0 (1.8-9.0), $p < 0.001$	1.0	2.5

Table 5. Injury risk in the context of children's daily routine.

Case studies

Case 1: Fall from a rooftop. An 8-year-old boy is alone flying a kite from the roof of a mosque on a Sunday morning. His mother, whose only income is 1500 Rupees (USD 30) per month of charity from the mosque, takes care of seven children in a two-room house where there is no space to play. The boy falls 10 meters and sustains a serious head injury and multiple long bone fractures.

Case 2: Road collisions. A family from Kohistan sets up camp in Rawalpindi. The family of eight has an income of less than 1500 Rupees (USD 30) per month. The 6-year-old daughter is walking alone from market on a Tuesday afternoon when she is struck by a taxi. She is admitted with an open fracture of the tibia. Three evenings later her 9-year-old brother is walking alone to visit her at the hospital and is struck by another taxi. He is admitted with a serious skull fracture.

Case 3: A fatal burn. A 12-year old girl is preparing morning tea over a kerosene stove on the floor of her family's one-room in a *kacchi abadi* (low-income settlement of crudely made homes). Her mother is deceased, leaving her responsible for the housework and care of her five younger sibs while her father works. She never attended school. Income for the seven family members is 3000 Rupees (USD 60) per month. The girl's clothing is ignited by the cooking fire and she sustains second- and third-degree burns to 80% of her body. She dies 12 days later of sepsis and disseminated intravascular coagulation.

DISCUSSION

Types of injury

Falls. These were the most prominent cause of injury in our sample, accounting for 59% of injury admissions. An Indian study found similar results, with 44% of children injured by a fall (Tandon et al, 1993). This is in contrast, however, to studies in Iran (Soori and Naghavi, 1998) and Thailand (Kozik et al, 1999), where falls were less common than motor vehicle collisions. Falls occurred in both urban and rural areas, mostly from the roof of the child's home. Compared with other causes of injury, they were associated with a low rate of adult supervision (15%).

Figure 4: Pakistani children often fly kites from the roof.

Roofs in Pakistan are flat, and families often use them for chores and a place to relax outdoors. Many families consider the roof a suitable play space, conveniently located and free from traffic. Play was the most common activity when falls occurred (cf. Lam et al, 1999). The majority of Pakistani roofs are unprotected, and the vast majority of fall victims in our sample fell from unprotected roofs (cf. Tandon et al, 1993). A special cultural issue is kite flying, which is very popular in northern Pakistan and is the centerpiece of the *Basant* celebration in early spring. Kite flying also carries the risk of electric shock.

Figure 5: A Pakistani boy on the roof of his rural home.

Road collisions. These accounted for 16% percent of injuries in our sample, consistent with the result of 26% found in India by Tandon et al (1993). Typically called motor vehicle collisions (MVCs) or Road Traffic Accidents (RTAs), we have called them road collisions to reflect that 68% of the victims were pedestrians and 18% were playing on the roadside, leaving only 14% passengers. Similarly, Luby et al (1997) found that 46% of adult road collision patients in Karachi had been pedestrians. Most collisions in our study occurred during the day, and compared to other causes, were associated with higher levels of adult supervision, albeit only 36%. Compared to other types of injury, victims of road collisions were low-income. They were more likely to live in tents or squatter settlements (not shown).

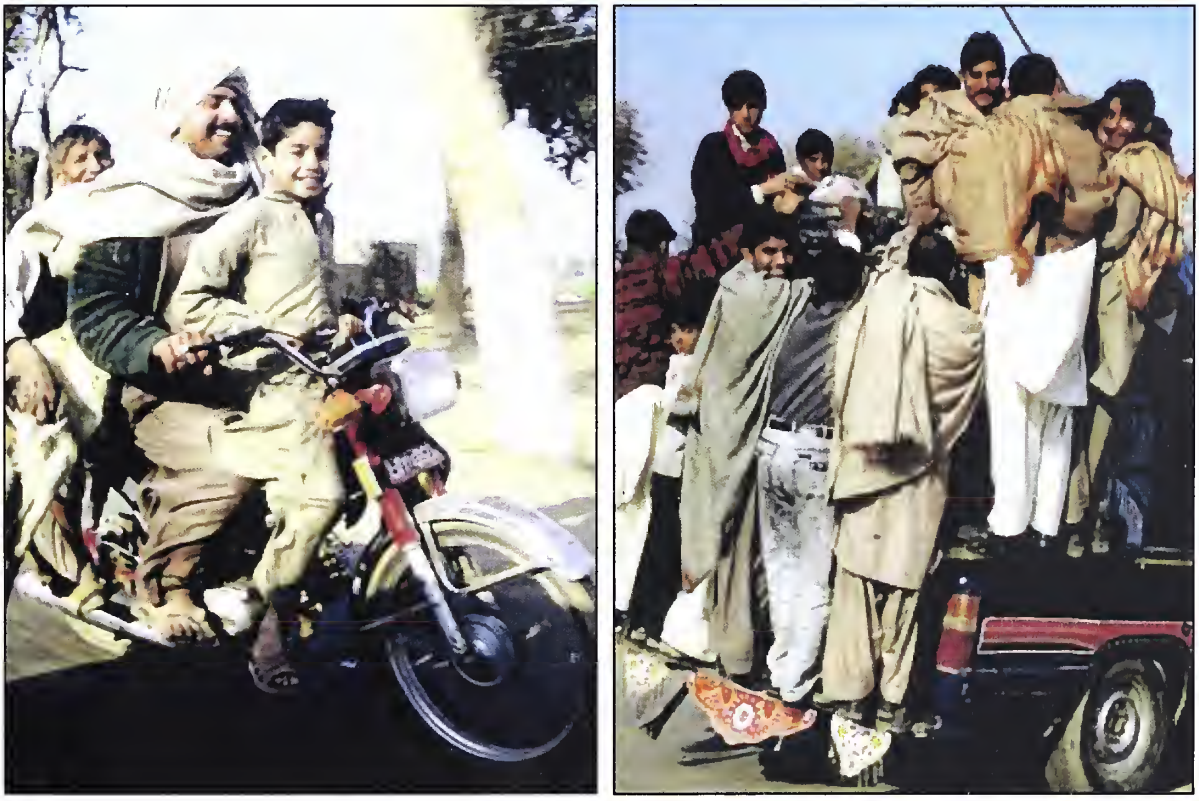

Figure 6: Examples of risky behavior on Pakistani roads.

There is a paucity of sidewalks in Pakistan. Where the government has provided sidewalks and pedestrian overpasses, pedestrians frequently fail to use them. Pedestrians often walk with their backs to traffic. Traffic law enforcement is inconsistent. Many cars lack seatbelts, and education about seatbelt and helmet use is poor. One positive aspect of road traffic in Pakistan is that due to prohibition on alcohol, there is a very low prevalence of drunk driving (see Mirza and Arif, 1999).

Fires. This was the third principal cause of injury, accounting for 13% of the sample. Notably, half of fire victims were girls, compared to falls and road collisions, for which boys were over-represented. This reflects that girls spend more time in the kitchen.

Figure 7: Ground-level stoves and loose clothes contribute to burns (photo from a rural home).

Older girls, for whom Islamic tenets on women's honor apply, have less freedom outdoors and assume many kitchen responsibilities. Pakistani females typically wear loose clothing, which ignites easily (Figure 7). The vast majority of burns were at home, from fires at ground level (cf. Lari et al, 2002). There was a clear association between burns and meal times, particularly supper time.

Foreign bodies. These represented the next most common type of injury. All seven cases involved common foods or objects (corn, peanuts, coins, or whistles). Small children were most at risk.

Animal attacks. Two children were attacked by horses, and one by a wild boar. No snake bites or scorpion stings were found, but these would be expected in warmer months.

Toxins. The two cases of poisoning (kerosene, thyroid hormone pills) illustrate the need for child-proof containers. Tandon et al (1993) found kerosene to be a key source of poisoning in India. Medications are commonly sold loose or in blister packs.

Intentional injuries. We found only two cases of intentional injury: one child shot by an unknown adult and one pushed from a swing by a peer. We were surprised to find no cases of child abuse in our sample. We do have helpful results, however, from a pilot study of children treated and released from the CH emergency department (Singer et al, in preparation). A father admitted hitting his 10-year-old son with a cricket bat because he had not done his homework; this resulted in hand fractures. A mother reported holding her baby

upside-down and shaking her because she was crying, leading to a fractured femur. The parents were perfectly candid in describing what had happened. The most likely explanation for our results is that our sample of 150 admissions was not sufficient to detect a serious case of child abuse.

Causes not observed. Many types of injury were not observed in this study, but may still be important causes during other times of the year or in particular contexts. These include (1) snake bites and scorpion stings, which only occur in warm weather; (2) drownings, which of course occur near bodies of water and more often during warm weather (see Soori and Naghavi, 1998; Ahmed et al, 1999); (3) unintentional gunshots, which occur most commonly when men, especially in the NWFP, fire weapons to celebrate weddings, births, and holidays; (4) sexual assault, which families may conceal; (5) pesticide poisoning, which of course is more common in the growing season; (6) land mine explosions or terrorism-related wounds, especially for Afghanis and Kashmiris (see Figure 7); and (7) violent crime. Technically, children who expire in the field are brought to the hospital, but in reality this does not always happen. This would have the tendency to under-represent homicide, drowning, and other rapidly lethal causes of death.

Poor child supervision

Poor supervision is a recurrent theme in our results. Only 21% of the children in our sample were supervised by an adult when the injury occurred. Supervision was best for road collisions (36%) and worst for falls (15%).

Case-control study

Differences. Cases were more likely than controls to be older and come from families with more income, less maternal education, more children in the home, fewer rooms in the home, and tents for shelter.

Age. Cases were older than controls ($p < 0.001$ by chi-square and LR model). This may reflect increased risk of injury for older children; however, most of this difference is likely to be an artifact of our control group. Controls were randomly selected from non-injury patients, but due to the pediatric epidemiology of Pakistan, this sample comprised mostly infectious and congenital diseases of early childhood (see Limitations, below).

Income. Many studies have shown that in comparison with the general population, low-income families have more risk of injury (see Innocenti Research Centre, 2001; Roberts and Power, 1996). Compared to our control group (mean 4350 Rupees per month), however, our cases reported more income (5570 Rupees; $p = 0.045$ by chi-square, $p < 0.001$ by LR model). This result has at least three interpretations. First, one could postulate that more income indeed correlates with more risk of injury, but in view of the literature we

believe this is unlikely. Second, families with high income may have been more likely to bring their injured children to Islamabad (a relatively wealthy city), instead of opting for less expensive, less advanced care in local hospitals; however, this is not supported by our result that 72% of cases came from Islamabad and Rawalpindi, compared to only 56% of controls. Third, the difference in income may reflect the composition of our control group. Common diagnoses in the control group, such as respiratory infections, are more prevalent in low-income populations. Both cases and controls may have been low-income compared to the whole population, but controls were poor in comparison to cases. We appreciate that self-report income is an imprecise measure; however, given our sample sizes of 150 and 150, we believe the income result provides a rough guide. The value of this result is to show that other injury risk factors (less maternal education, type of shelter) were not confounded with low income.

Maternal education. In comparison to controls, cases had mothers with less education ($p = 0.016$ by chi-square; $p = 0.050$ by LR) In fact, 53% of cases mothers had never attended school.

Rooms in home. This is the first of two results that point to crowded homes as a key risk factor. Case homes had fewer rooms than control homes ($p = 0.023$ by chi-square, $p = 0.003$ by LR).

Children in home. This is the second result pointing to crowded homes. Case homes had significantly more children ($p = 0.047$ by chi-square but eliminated from LR model).

Type of shelter. Cases were more likely to live in a tent than controls ($p = 0.023$ by chi-square, $p = 0.033$ by LR). Most of these children were Afghani refugees, lived near busy roads, and were hit by motor vehicles.

Sex. In every country studied, boys have shown higher overall injury rates than girls (see Innocenti Research Centre, 2001). We found similar results, with 67% males and 33% females; possible explanations include more social liberty for boys and riskier play behaviors. For burns, however, the distribution was 50% and 50% (see above). A result we did not anticipate was that the control group also consisted of 67% males and 33% females ($p = 0.902$ and eliminated from LR model). These values differ dramatically from the nearly equal numbers of boys and girls found in the Pakistan 1998 census (Government of Pakistan, 1998). What can account for this difference? We considered that predisposition to specific diseases may have rendered boys more frequent candidates for medical treatment; however, we found the 67:33 sex ratio to be consistent for a number of different diagnoses, such as upper respiratory infections and birth defects. Rather, the most reasonable hypothesis is that families took boys to the hospital more readily than they took girls. The literature has established that Pakistani families often favor male children with more resources and social liberties, even to the point of compromising the health and nutrition of females (Ahmad, 2000; Lovel et al, 1984; Khosla, 1984; Winkvist and Akhtar, 2000). Carefully designed household-based studies will be needed to test this hypothesis and

understand how families make careseeking decisions. Do families recognize illness in girls as easily as they do in boys? Do they take girls to smaller clinics in lieu of the hospital?

Vaccination. Cases and controls showed no differences in vaccination rates (p = 0.947). Both groups showed rates of ~85%, a reflection of successful national vaccination programs.

Temporal risk patterns

Children were relatively safe between 9 PM and 6 AM and faced the most risk between 3 PM and 6 PM. While the risk for preschoolers declined sharply after 6 PM, it remained elevated for students until 9 PM. These patterns can be interpreted in view of the child's schedule: sleep is the safest activity, and after-school or afternoon play is the most perilous.

We saw no difference between Ramadan and the month immediately before. The study was conservative, however, since it was carried out in the winter, when the fast is shorter and the weather cooler. A more definitive study should examine Ramadan in other years or compare countries in the Northern and Southern hemispheres.

Weekends and holidays were associated with the most risk of injury for students, with an OR of 4.0 ($p < 0.001$) compared to preschoolers and 2.5 ($p < 0.001$) compared to the model. Students were relatively safe at school with an OR of 0.1 ($p < 0.0001$) compared to preschoolers and 0.2 compared to the model (however, see Maitra, 1997). In contrast,

preschooler did not vary in injury frequency, with ORs of ~1 for most time periods. These results provide several convergent lines of evidence for the importance of adult supervision. They further show that more vigilance is needed on afternoons, weekends, and holidays.

Limitations

Sample size. The sample of 150 cases and 150 controls provided sufficient power and a clear picture of most common injury types but may not have been sufficient for less frequent types (drowning, gunshot).

Selection bias. While 190 children met case eligibility, only 150 could be recruited. For most of the remaining 40, the parents could not be contacted, or the parents took the child within 24 hours, often contrary to medical advice. These parents may have differed in their socioeconomic status, or the children may have differed in the severity of their injuries. Since these families accounted for only 21% of those eligible, the effect, if any, is likely to be minimal.

Study location. The choice of a tertiary care hospital helped to ensure a wide catchment area and range of injuries; however, families practice self-selection in decisions to come to Islamabad. This may reflect the severity of injury, family income, and other socioeconomic descriptors.

Catchment area. The study recruited children from a geographically, ethnically, and economically diverse catchment area; however, this only represents a portion of Pakistan's

diversity. Further work is needed to test whether these results generalize to other regions of Pakistan.

Severity of injury. We limited our study to children admitted to the hospital. Our sample may not generalize to children who die outside of the hospital or those who are simply treated and released

Controls. A shortcoming in our case-control design is underscored by the difference in age between cases and controls; however, we still believe the control definition we used was the best available. A community-based control group would have been impractical due to the poorly defined catchment area and socioeconomic disparities in different parts of the catchment area. Matched hospital subjects would have been undesirable, since many medical patients over five years old have chronic or congenital diseases, which would have been serious confounding factors.

Summary of findings

Falls, road collisions, and burns were the most common causes of serious injury in our sample of Pakistani children. Injuries commonly occurred in the afternoon, and for schoolchildren, more commonly on weekends. The study identified three recurrent risk factors: (1) lack of adult supervision, (2) crowded homes, and (3) poor maternal education.

Strategies for injury prevention in Pakistan

The results make it possible to suggest a number of strategies and high-priority steps to prevent child injury in Pakistan (see Forjuoh and Li, 1996; Grossman, 2000; Mohan, 1986).

High-risk populations. Interventions should first focus on households with any of four characteristics: (1) little or no maternal education; (2) small homes; (3) more children; or (4) tents for homes. Potential starting points include low-income, *kacchi abadi* settlements and refugee camps. Further studies will be needed to determine where interventions should focus in strictly rural contexts.

Adult supervision. Interventions should seek to improve child supervision by parents, teachers, and police officers. These parties may be educated by way of: (1) the Pakistan Lady Home Visitor Programme; (2) pediatric check-ups; (3) cooperation with religious leaders; and (4) formal police and teacher training. Mothers may be overwhelmed by child care and household duties, so future research and interventions should explore ways to provide supervision by other adults. One possibility would be to improve school enrollment and appoint adults to supervise play areas. The cost of these measures may be offset by reductions in medical and other social costs.

Play areas. Children should be educated to stay off roofs, and these lessons should be incorporated into the curriculum of each province. Building owners should be

encouraged or required to build protective structures around roofs. At the same time, funds should be allocated to build and maintain safe playgrounds.

Pedestrian safety. Separate sidewalks should be built beside busy roads. This would not only protect pedestrians but improve the flow of motorized traffic. Children should be educated to stay on sidewalks whenever possible and face traffic as they walk. School uniforms should include bright colors and reflective tape, two low-cost interventions.

Vehicle safety. Auto manufacturers should be required by law to include seatbelts in all vehicles. Seatbelt and helmet use should be promoted by advertisements. Research is needed to find better ways to render seatbelts and helmets more comfortable in Pakistan's hot climate. Steps should be taken to improve the enforcement of speed limits. Violators should be fined, with the proceeds devoted to traffic safety measures.

Fire safety. Families should be educated to keep children out of the kitchen and away from hot liquids. Loose-fitting clothes, such as the traditional *dupatta*, should be made out of flame-retardant materials.

Hazardous substances. Stores should be required to dispense medications and toxins in child-proof containers.

Conclusion

With over 60 million children, Pakistan is home to one of the world's five largest pediatric populations. As in many countries, child injury has become one of Pakistan's most pressing public health problems. The social and financial burden have important implications for Pakistan's development. The results of this study will be useful in guiding future injury research and focusing injury prevention efforts on children most at risk.

Figure 8: Safe play spaces and supervision reduce the risk of injury.

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